May 12, 1999

By Hand

Ms. Magalie Salas
Office of the Secretary
Federal Communications Commission
The Portals
445 Twelfth Street, S.W., Room TW-A325
Washington, D.C. 20554

Re: Ex Parte Meeting, CC Docket 94-102, Enhanced 911, TTY Compatibility with Digital Wireless Systems

Dear Ms. Salas:

On April 6, 1999, Stephen Benno, John Marinho, Susan McNeil, Michael Recchione, and I of Lucent Technologies, Inc. met with several members of the Commission, including Nancy Booker, Pam Gregory, Dale Hatfield, Marty Liebman, and Elizabeth Lyle, to discuss Lucent's efforts to develop a solution to the TTY-digital wireless system compatibility problem. Mr. Benno gave a brief presentation describing Lucent's promising work on this issue. Attached are the handouts presented at this meeting.

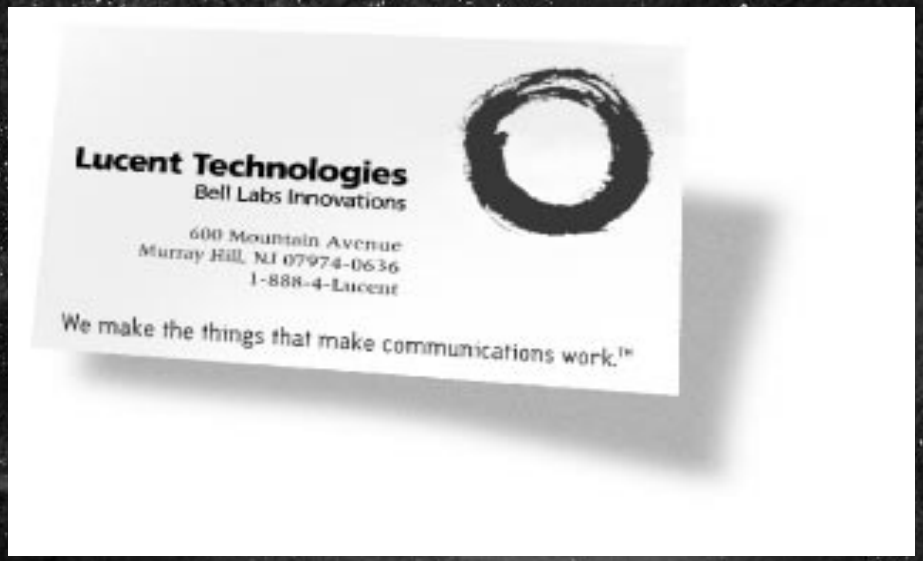
Enclosed please find an original and two (2) copies of the handouts. Also enclosed is a copy to be stamped and returned for our files.

Please do not hesitate to contact me should there be any questions.

Sincerely,

Diane Law Hsu

Audio Solution for TTY/TDD in Digital Wireless Communications



Steven A. Benno, Ph.D.
Member of Technical Staff
Speech and Audio Processing Technology

TTY/TDD Audio Path Solution

Desired Goals

- Target CER < 1%
- Support VCO/HCO
- Near term availability
- Interoperable with existing standards
- Low Complexity
- Non-invasive to vocoder

Challenges:

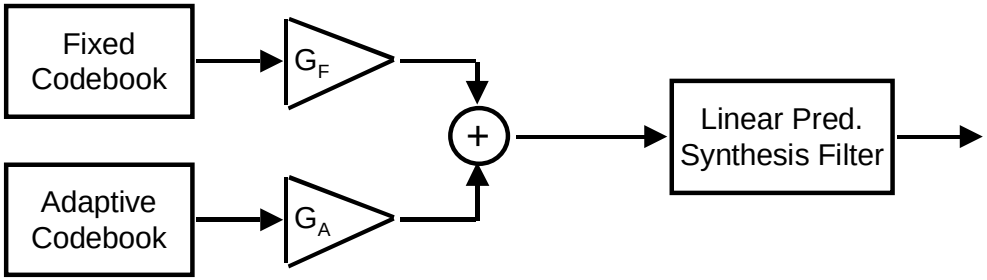
- CDMA
  - Frame Erasures
  - Noise Suppression
  - Variable Rates
- TDMA/GSM
  - Bit Errors
  - Frame Errors

Background: The Baudot Code

- Most TTY/TDD support the Baudot Code
  - Half-Duplex Frequency Shift Keying (FSK)
  - Asynchronous
  - Carrierless
  - No Error Protection/Correction
  - Bit Duration 22 ms. (45.45 Bit/s)
  - TTY Character
    - 1 Start Bit (logic 0)
    - 5 Data Bits
    - 1.5-2 Stop Bits (logic 1)

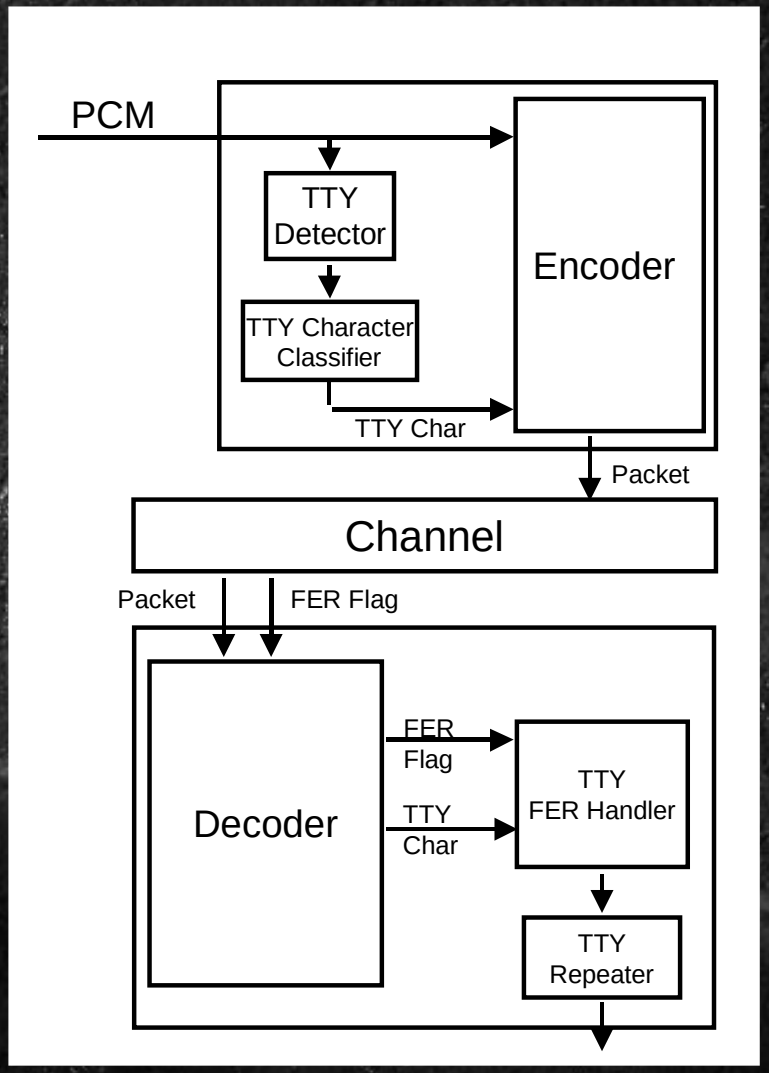
Background: CELP Speech Coders

- **Speech Processing Frame:** 20 ms.
- **Linear Prediction Filter:** Short Term Predictor
- **Adaptive Codebook:** Long Term Predictor
- **Fixed Codebook:** Noise Component



No Gain Solution

- **Detect TTY characters in the encoder.**
- **When a character is detected, zero the adaptive codebook contribution and transmit the character and header information to the decoder.**
- **The decoder detects when the adaptive codebook contains TTY information and overwrites its decoded output with regenerated Baudot signals.**
- **Redundant character information is transmitted for 8 frames, allowing decoder to recover from FERs.**



Benefits of No Gain Solution

- Interoperable
- Passive
- Supports VCO/HCO
- Low Complexity
- Vocoder software upgrade
  - Modification to encoder
  - Modification to decoder
- Marginally improves CER when interoperating with unmodified vocoder
- Near term availability

Simulation Results: EVRC w/ TTY Solution

Frame Erasures	Character Errors
0%	0%
1%	0%
2%	0%
3%	0%

Simulation Results: TDMA @ 10 Hz. Doppler

	Character Error Rate	
Channel Condition	Lucent TDMA-6	IS-641 with TTY Solution
Clear	0 %	0 %
25 dB C/N	0 %	0 %
21 dB C/N	0 %	0 %
18 dB C/N	0 %	0 %
16 dB C/N	0 %	0.2 %
14 dB C/N	0 %	0.3 %

Standards Work

- TR45.5 - CDMA
  - Requested PNs to modify IS-127 and IS-733
  - Baseline Text for April Meeting
  - Ballot Text for June Meeting
- TR45.3 - TDMA
  - Request PNs in May Meeting to modify IS-641
- North American GSM